

not forget that its present size and arrangement are due, not only to the seven men mentioned above, but also to nineteen years' work from Mr. Christie, the present Astronomer Royal. In these nineteen years he has contributed to the buildings and equipment about as much as his seven predecessors together. There is a new transit-circle, which can be used on or off the meridian; the 13-inch refractor has been increased and multiplied into a 28-inch visual refractor, a 26-inch photographic refractor, and a 30-inch reflector, besides the 13-inch astrographic equatorial; and a large, commodious building has been erected, which more than doubles the space available for computing, measuring photographs, and all the miscellaneous duties of which the lay-mind has probably never imagined the existence. In this noble extension of our National Observatory, the Astronomer Royal has been generously helped by others, and especially by Sir Henry Thompson, who gave two of the large telescopes, and by Mr. Crisp, the architect of the new buildings, whose name we are sorry not to find in Mr. Maunder's book.

On one day in the year, "Visitation Day," the Observatory is devoted to visitors; and though it is not even then thrown open to the public, those with a definite interest in astronomy can generally obtain a card of admission. They find a great many things to see—those who see them for the first time find the number and variety almost bewildering; there is, in fact, the year's work of fifty busy people to look at, as well as the complicated instruments with which it was done. Things have changed somewhat, in spite of the reluctance of economical Governments, since Flamsteed was installed as Astronomer Royal in 1676 with a salary of 100*l.* a year, a "surly labourer" to help him, and no instruments! To such as are fortunate enough to be admitted on these annual occasions we can recommend the later chapters of the book for perusal both before they go and after they come away; a number of technical matters are described in a thoroughly attractive way.

Sometimes in reading a book a stray sentence or two impress the memory, though they may be only incidental to the main theme. Pond's notion of the kind of man who would make a good assistant in an observatory arrests the attention:—

"I want indefatigable, hard-working, and, above all, obedient drudges (for so I must call them, although they are drudges of a superior order), men who will be contented to pass half their day in using their hands and eyes in the mechanical act of observing, and the remainder of it in the dull process of calculation."

There is undoubtedly a vast amount of drudgery in astronomy, if people choose to so regard it. Other sciences multiply their observations ten or a hundred times; the astronomer deals in thousands and even millions. But men with the spirit of drudges, as Mr. Maunder truly remarks, cannot be trusted to do the work honourably and therefore accurately; and besides this the work is *not* drudgery. Mechanical it may be, but good men and true have found it far from dull. Did Herschel find it dull to pass the whole heavens in review star by star? Does Mr. Denning, of Bristol, find it dull to watch night after night for long hours on the chance of observing a few meteor-tracks, and that after

a day's business toil? If it were drudgery they would have stopped, but Herschel went on, and Mr. Denning goes on, and these are only two random instances out of hundreds.

At the same time Pond put his finger on a real difficulty, which is just as pressing to-day, nay, far more pressing since the introduction of photography into astronomy has so enormously increased the work. How are we to get through this work? The army of astronomers is so small; it has not been recruited with sufficient rapidity to keep pace with the extension of our Empire. Pond thought of drudges, as commanders of old employed mercenaries: both found them unsatisfactory. What is the real solution? Conscription will scarcely work here. Will the volunteers solve the difficulty, or may we hope for a big reorganisation scheme?

H. H. T.

THE MANAGEMENT OF ROADS.

Road-making and Maintenance: a Practical Treatise for Engineers, Surveyors and Others. By Thomas Aitken, Ass.M.Inst.C.E. Pp. xvi + 440. With numerous plates and illustrations. (London: Charles Griffin and Co., Ltd., 1900.)

SINCE the introduction of bicycles and motor-cars the question of road maintenance has come very much to the front. It formed one of the subjects discussed in Section G at the late meeting of the British Association, and was considered of sufficient importance to warrant the appointment of a committee to inquire generally into the subject, but more especially as to the effect of the condition of the surface of roads on the tractive force required to move vehicles along them.

The author of the book under notice has given an interesting account of the history of road-making from the time of the ancient inhabitants of Peru, and of the Romans, to the days of road revival in this country, when General Wade was employed by the Government in constructing about 250 miles of roads through the Highlands of Scotland as the most effectual means of putting an end to the Rebellion of 1715.

Then followed the establishment of turnpike trusts, no less than 1100 Acts of Parliament having been passed for this purpose, and a very large amount of capital was raised for opening out new, or improving old, roads. In this work Telford, the father of modern civil engineering, constructed over 900 miles at a cost of nearly half a million of money. So great was the revolution in the condition of the roads that Macadam, another of the great road-makers, was described as being regarded by the public as a sort of magician, and his invention something preternatural. As the result of their work it became possible to run stage coaches between the principal centres of population at the rate of ten miles an hour. The establishment of railways and the termination of the turnpike trusts under provisions contained in the Acts of Parliament led to the decadence of the main roads of the country, the management of the old turnpikes having reverted to the parochial surveyors. A certain amount of improvement took place when the system of grants out of the county rates towards the maintenance of the main lines of communication was introduced, these

grants being subject to the roads being kept in repair to the satisfaction of the county justices. A further improvement took place when these roads were taken over by the County Councils.

The bicycle has, however, been the main agent in recent road improvement. To use these machines with any comfort a road must be in thoroughly good order, level, and free from loose stones and mud. The voice of the bicyclist is heard everywhere calling out when roads are in bad order, and local legislators are driven both by their own experience and that of their constituents to bring about a better condition of the main roads and highways. An institution known as the Roads Improvement Association has been formed, and, besides bringing pressure to bear on the local authorities, has issued a great quantity of literature for the guidance of local surveyors and roadmen as to the management of the roads; upwards of 13,000 pamphlets containing practical information on the management of roads have been distributed by this society.

Fortunately road reformers are able to show, by conclusive evidence, that roads kept in thoroughly good order cost less in annual maintenance than when they are left to get rutty and uneven and covered with mud or loose stones.

Mr. Aitken's book is a good practical treatise on the making and maintenance of roads. It is divided into fifteen chapters, which deal respectively with the history of road-making; traction; the construction of new roads; bridges, culverts and retaining walls; road material; quarrying; stone-breaking and haulage; road-rolling and scarifying; paved roads, including wood, asphalt, brick, and tar macadam; footways, &c.

The book deals principally with main roads and those subject to heavy traffic, which, as a rule, are now under the care of the county surveyors, who are skilled experts, and very little attention has been given to the requirements of the ordinary highways, where improvement is most required. The space devoted to quarrying, which occupies no less than sixty-seven pages, or about one-sixth of the whole book, could well have been spared, as it is rarely in these days that a surveyor has to quarry his own road material, and the space would have been better devoted to showing how ordinary highways may be maintained in good order and kept level and clean, and material placed on them when required without inconvenience to the traffic in situations where steam road-rolling is impracticable.

OUR BOOK SHELF.

Knowledge, Belief and Certitude. By F. Storrs Turner. Pp. viii + 484. (London: Swan Sonnenschein and Co., Ltd., 1900.) Price 7s. 6d. net.

MR. STORRS TURNER distinguishes knowledge from consciousness as interpretation from datum. He alleges as base of the former three certitudes, as to self, other selves and real things. He finds the sciences to involve the same pre-conditions and to take a permissibly abstract point of view—that of a fictitious independent spectator. But he holds that, therefore, the sciences are not adequate to concrete reality, while the pretension of science in general to present the whole is vain. In psychology the standpoint of the ideal spectator is

inadmissible, and philosophy has failed because of the same abstraction. But among concrete ends we find our conviction as to some certain knowledge satisfied. Real knowledge belongs to the teleological sphere.

His conclusion to the failure of the speculative and the success of the purposive reason surprised Mr. Turner with the force of a revelation. The first chapters of his inquiry, which "remain substantially as they were originally written," were committed to paper years ago when "a dense fog" covered his mind. A trace of this is to be found in the attempt to maintain concurrently that the certitude of other selves is an inference of reason (p. 74), that it is plainly one with the certitude of self (p. 89), and that neither is able to come into existence apart from the other (p. 95). Mr. Turner can say within a page that "by real things we mean permanent things" (p. 80), and that "what we have is the certitude that there are a multitude of real things, some of them permanent, most of them changing" (p. 81). It will perhaps be unnecessary to say that his verbal criticism on such writers as Mr. F. H. Bradley depends for its validity on a hit or miss principle. It is a little grotesque to have estimates of Hegelian metaphysics and post-Hegelian logic from the standpoint of "reflective common-sense, aware of its limitations." Mr. Turner thinks that continuity implies indivisibility, and his verdicts on much in philosophy and science rest on similar misunderstandings.

"Knowledge, Belief and Certitude" is, however, by no means a worthless book. There is a certain dialectical ability in much of it, and a tenacity as to main principles which will appeal to the clear-headed reader who can discount the fallacious element. It is, however, as an honest attempt to think the problem of knowledge right through, and to present a record of the process as well as the results of his investigation, that it chiefly commends itself. How and why Mr. Turner came to his estimate of various views and systems, rather than that estimate itself, is the thing worth studying.

H. W. B.

Notions de Minéralogie. Par A. F. Renard et F. Stöber. 11^{me} Fascicule; Classification et Description des Espèces Minérales. Pp. 191 to 374. (Gand: Ad Hoste, 1900.)

THE first fascicule of this text-book, containing the general principles of mineralogy, has already been noticed. The second fascicule (pp. 191–374) is devoted to the detailed description of mineral species. A large number of species are mentioned and, consequently, the majority are only briefly treated; in its main features the book necessarily resembles other mineralogical text-books.

It seems that, by a wise provision, all candidates in natural science at the University of Gand devote one hour weekly to the study of mineralogy, and it is for these students that the book is primarily intended. From this point of view we think that, as in most text-books, more species are mentioned than is necessary; such rare minerals, for example, as chalcocite and nitrobarite should scarcely come within the range of the elementary student, but the brief descriptions of the commoner minerals leave nothing to be desired.

There are several useful features in the book which deserve special mention. In the case of most of the minerals of commercial importance, such as mica, apatite, cassiterite, galena and sulphur, a statement is given of the annual world's yield and its approximate value.

Another important feature is a summary of the minerals of Belgium with their localities, with which the volume concludes. Such local information is extremely useful, and this is the first authentic list of Belgian minerals and localities which has been given. The list has evidently been compiled with care; special attention is